CLAIMS

What is claimed is:

1. A plasma immersion ion implant apparatus comprising:

a plasma chamber configured to receive a process gas;

a radio frequency (RF) source configured to resonate radio frequency currents in a radio frequency antenna;

a radio frequency antenna including an active antenna surrounding the plasma chamber and coupled to the RF source and a parasitic antenna surrounding the plasma chamber and not directly coupled to any RF source; and

a platen for holding a target,

wherein electro-magnetic fields induced by the radio frequency currents are effective to pass into the plasma chamber and excite and ionize the process gas to generate plasma within the plasma chamber.

2. The apparatus of claim 1, wherein the active antenna includes a horizontally-extending coil and the parasitic antenna includes a vertically-extending coil.

3. The apparatus of claim 1, wherein the active antenna includes a vertically-extending coil and the parasitic antenna includes a horizontally-extending coil.

4. The apparatus of claim 1, wherein the parasitic antenna includes a plurality of turns with one end grounded.

5. The apparatus of claim 4, further comprising means for adjusting a number of turns of the parasitic antenna providing a parasitic effect.

6. The apparatus of claim 1, wherein the parasitic antenna includes a plurality of turns with both ends floating.

7. The apparatus of claim 1, wherein an inner diameter of each antenna is greater than a size of the target.

8. The apparatus of claim 1, wherein the parasitic antenna is above and coaxial with the active antenna.

9. The apparatus of claim 1, wherein at least one antenna is liquid cooled.

10. The apparatus of claim 9, wherein the parasitic antenna is coupled to the plasma chamber via a thermally conductive elastomer.

11. The apparatus of claim 1, wherein the plasma chamber includes:

a horizontal planar section positioned above the platen;

a vertical cylindrical section extending from the horizontal planar section; and

a top section coupled to the vertical cylindrical section.

12. The apparatus of claim 11, wherein the horizontal planar section and vertical cylindrical section are dielectric, and the top section is conductive and grounded.

13. The apparatus of claim 12, wherein the horizontal planar section and vertical cylindrical section are formed of a high purity ceramic material.

14. The apparatus of claim 13, wherein the high purity ceramic material is >99.6% Al_2O_3, AlN, Yittria or YAG.

15. The apparatus of claim 12, wherein the top section is formed of Al.

16. The apparatus of claim 11, wherein the top section is liquid cooled.

17. The apparatus of claim 1, further comprising a plasma igniter for introducing a strike gas into the plasma chamber to assist in igniting a plasma.

18. The apparatus of claim 1, further comprising a gas source controller for maintaining a pressure of the plasma chamber at a predetermined value.

19. The apparatus of claim 1, wherein the RF source operates at a low RF frequency.

20. The apparatus of claim 19, wherein the low RF frequency is less than 27MHz.

21. The apparatus of claim 19, wherein the low RF frequency is 400 KHz, 2 MHz, 4MHz or 13.56 Mhz.

22. A method of plasma immersion ion implantation, the method comprising the steps of:

generating an ionic plasma by exposing a process gas to a radio frequency (RF) source via a first active coil;

tuning the ionic plasma by parasitically damping via a second parasitic coil that is not connected to any RF source; and

implanting a target using the ionic plasma by providing a negative voltage to the target.

23. The method of claim 22, wherein the generating step further includes introducing a strike gas to the RF source.

24. A plasma chamber comprising:

a horizontal planar dielectric section for positioning above a platen;

a vertical cylindrical dielectric section extending from the horizontal planar section; and

a liquid cooled top conductive section coupled to the vertical dielectric section.

25. The plasma chamber of claim 24, wherein the top conductive section is grounded.

26. The plasma chamber of claim 24, wherein the top conductive section is liquid cooled.

27. The plasma chamber of claim 24, wherein the vertical dielectric section is configured to couple to, via a thermally conductive elastomer, a parasitic antenna that is not coupled to any radio frequency (RF) source.

28. The plasma chamber of claim 27, wherein the parasitic antenna includes a plurality of turns with one end grounded.

29. The plasma chamber of claim 28, further comprising means for adjusting a number of turns of the parasitic antenna providing a parasitic effect.

30. The plasma chamber of claim 27, wherein the antenna is liquid cooled.

31. The plasma chamber of claim 24, wherein the horizontal dielectric section is configured to support an active radio frequency antenna that is coupled to a radio frequency (RF) source.

32. The plasma chamber of claim 24, further comprising a process gas inlet and a strike gas inlet.